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SUMMARY

Problem

Adverse physical and psychological health outcomes following disasters have been widely reported in epidemiologic literature. However, these studies have primarily examined disasters in the civilian population. Military personnel are at particular risk of involvement in disasters because of the hazardous nature of their duty.

Objective

The objective of this study is to assess the impact of disasters (events involving multiple deaths or injury hospitalizations) on the health status of Navy personnel by examining the occurrence of medical and psychological outcomes in the post-disaster period, and to compare them with a group of patients who were hospitalized for non-disaster related causes, to see what the effect of the disaster was on the case group.

Approach

Naval enlisted personnel who were hospitalized survivors of disasters occurring between 1966 and 1979 were compared with personnel hospitalized for problems not resulting from disasters. Hospitalization, medical board, and physical evaluation board rates for the post-disaster period were compared between the two groups. Life table analyses were utilized to compare the time from disaster to these medical events among cases and controls.

Results

Cases and controls did not differ significantly in their post-disaster medical event rates and diagnoses. However, it was found that psychiatric diagnoses occurred earlier in the post-disaster period among cases than among controls. Additionally, the risk of post-disaster accident-related diagnoses was significantly elevated in the 17-19 year old group.

Conclusions

This study disclosed that military personnel involved in disasters are likely to have an administrative outcome and medical course that is similar to other hospitalized patients. However, by comparison, disaster victims' mental

health problems are likely to occur following involvement in a disaster and, for the 17 to 19 year old group, there is an increased possibility of their being involved in accidents in the future.

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The effects of disasters on the victims' physical and psychological health are important to investigate because these events commonly affect large numbers of people in the world today. Disasters may be due to natural causes such as weather, or to man-made causes such as the Three-Mile Island nuclear accident[1]. Military personnel are often involved with traumatic events during wartime, but even during peacetime they are exposed to hazardous situations which sometimes result in disasters.

A disaster is described by Kinston and Rosser[2] as a "situation of massive collective stress". Examples of disasters that are addressed in the epidemiologic literature include natural disasters such as a dam bursting,[3,4,5] a tornado,[6] a smog episode,[7] floods,[8,9,10,11,12] man-made disasters such as the Love Canal chemical dumpsite,[13] the collapse of a hotel skywalk,[14] a night club fire,[15] and a ship collision and sinking.[16] Many epidemiologic studies focus on disasters that affected entire communities or large portions of a community. In this sense, many disasters in the U.S. Navy can be viewed as events which affect "whole communities" because ships and military commands can be thought of as self-contained communities.

Disasters, analogous to other events and situations which involve severe stress, may be associated with both short- and long-term health consequences during the post-disaster period. Numerous controlled epidemiologic studies of both man-made and natural disasters have examined health outcomes among disaster victims. The results of these surveys generally indicate that both types of disasters are associated with a variety of short- and long-term adverse health effects. Ciocco and Thompson[7] and Schrenk, Heimann, Clayton, et al.[17] studied victims of the smog episode in Donara, PA (October, 1948) and observed higher mortality and morbidity rates among the victims during a nine year follow-up. During the one-year period following the floods in Bristol, England in 1968, Bennett[9] recorded higher mortality rates, more psychiatric problems, and hospital admissions than among residents of non-flooded areas. Melick,[12] Abrahams, Price, Whitlock, et al.[11] and Price[10] also reported similar results in studies of victims of floods. In a study of victims of the flood in Wyoming Valley, PA in 1972 resulting from tropical storm Agnes, Logue[8] and Janerich, Stark, Greenwald, et al.[18] reported significant increases

in adverse health outcomes such as severe headaches, bladder trouble, gastritis, and constipation among flood victims. When considering man-made disasters, Nailor, Tarlton, and Cassidy[13] have reported more miscarriages and birth defects among pregnancies occurring in women residing in the Love Canal area than would be expected for the general population.

Disasters have also been shown to be associated with post-traumatic stress disorder, bereavement, and other psychological disorders. Bromet et al.,[1] in a survey of mothers of pre-school children within a 16-kilometer radius of the Three-Mile Island disaster, reported increases in mental health problems over the study period. Mental disturbances were also found among the Three-Mile Island population by Wert[19] and Dohrenwend et al.[20]. Following the Coconut Grove fire in Boston in 1942, Cobb and Lindemann[21] observed neuropsychiatric problems among 14 of the 32 survivors, most involving bereavement. In the aftermath of a tornado in Dallas in 1957, Moore and Friedsam[22] reported emotional distress among family members surviving the disaster. Among survivors of the explosion on the Delaware River in 1957, Leopold and Dillon[23] reported increasing psychiatric disturbances up to four years after the accident. Other well-documented disasters demonstrating psychological symptoms in victims include the Bristol floods of 1968, the flood in Wyoming Valley, PA[8] and the Brisbane floods in Australia.[11]

The objective of this study was to assess the impact of disasters on U.S. Navy personnel surviving these events and to compare their post-disaster experience with a group of patients who were hospitalized for reasons unrelated to disasters. The study selected a cohort of Naval personnel hospitalized for trauma resulting from disasters. These disaster cases were followed during the post-disaster period to examine whether they experienced more health-related outcome events than personnel hospitalized for problems not resulting from a disaster. Hospitalized controls were selected to determine if the effects of the disaster event itself, and not the effects of hospitalization, could be assessed. Computerized records of hospitalizations, medical boards, and physical evaluation boards were used to compare the two groups.

Methods

It was found that no one list of Naval disasters existed; therefore, indirect means were used to identify them. Disasters were identified by searching computerized inpatient records using the following criteria: a cluster of

three or more people who died and/or were hospitalized following traumatic injury, occurring within three days of each other, at the same location, and due to an accidental cause, between 1966 an 1979. Disasters were identified by searching the Naval Health Research Center (NHRC) Health and Service History and Naval Safety Center (NSC) computerized databases, using the criteria defined above. Data from these two sources were combined, and duplicate entries or those not having both a name and an accompanying service or social security number, as well as combat-related hospitalizations, were excluded. Disasters identified in these initial computer searches were verified using a sample of U.S. Navy Judge Advocate General Investigations. Of the 64 investigations that could be found for review, all indicated a disaster had taken place. Deaths were verified by obtaining the death certificates of a sample of 100 men listed as fatalities and cross-checking within the NHRC and NSC databases for confirmation.

Because the dependent variables in this study were post-disaster events, only survivors of the disaster were included in the analysis. Information obtained on the cases included the date and primary through quaternary discharge diagnoses of all post-disaster hospitalizations, number of days hospitalized, medical and physical evaluation board information, rate, and pay grade.

The control group consisted of a stratified random sample of 3,534 Navy enlisted personnel. The random sample was obtained from the NHRC Health and Service History database. The selection process stratified Navy enlisted personnel into yearly cohorts and resulted in controls selected with equal probability during each study year between 1965 and 1979. Eight hundred and twenty one, or 23% of the 3,534 Navy controls, had at least one hospitalization during the study. This subset of Navy enlisted personnel with one or more hospitalization was chosen as the control group for the 795 disaster victims who were initially hospitalized for trauma associated with the disaster incident. The first hospitalization was used as an index hospitalization and was not included in estimates of the outcome events measured in this study. Information on medical events subsequent to the initial hospitalization was obtained for the controls, using the method described previously for the cases.

Baseline demographic information for cases was compared to that for controls. For the purpose of this analysis, "disaster" will refer to both disaster for cases and index hospitalization for controls, where values for

both groups are given. Means and rates were calculated for post-disaster hospitalizations, medical boards, and physical evaluation boards, and the means were compared between the two groups. Post-disaster diagnoses were grouped according to major NHRC disease categories. Age-specific incidence rates per 1,000 strength based on person-years of follow-up, relative risk estimates, and Miettinen's 95% confidence limits[24] were computed for each major diagnostic category. Life table analyses[25] were conducted to examine the time to response from disaster to the primary health outcome events (hospitalization, medical board, physical evaluation board, and psychiatric hospitalization), and to determine the 1- and 5-year incidence rates of these cases.

Results

Baseline Data

A final sample of 795 disaster victims and 821 controls was selected for analysis. The greatest percentage of cases were involved in land non-auto accidents (45.3%), followed by land-auto (31.2%), sea (15.7%), and air (7.8%). All cases and 97.9% of controls were male. Baseline demographic information for cases and controls at the time of disaster is presented in Table 1. The mean age was 20.1 years for cases and 22.8 years for controls. The average length of service between Naval enlistment and disaster was 1.5 years for cases and 3.6 years for controls. The majority of subjects were Caucasians and unmarried. The average follow-up time in the study was 31 months for cases and 36 months for controls, which was found to be significantly different between the two groups ($p<.01$). For cases, there were a total of 2060.5 person years at risk, whereas for controls there were 2463.2 person years at risk.

The majority of primary diagnoses for the disaster hospitalizations cases were trauma-related. In comparison, the primary diagnoses for the index hospitalization for controls were distributed among such categories as diseases of the respiratory system (19.6%) and trauma (18.5%), diseases of the digestive system (9.1%), mental disorders (8.6%), infective and parasitic diseases (7.8%), diseases of the skin and subcutaneous tissue (6.9%), and diseases of the musculoskeletal system (6.7%). Other diagnostic categories accounted for 22.8% of the primary diagnoses associated with the index hospitalization.

TABLE 1

DISTRIBUTION ON DEMOGRAPHIC AND OCCUPATIONAL VARIABLES

	Cases	Controls
Mean Age	20.1	22.8
Mean Length of Service (Years)	1.5	3.6
% Male	100.0	97.9
% Caucasian	90.0	91.0
% Unmarried	85.0	69.1
Pay Grade		
E1	21.5%	26.7%
E2	18.9	13.4
E3	33.8	24.2
E4	20.5	14.8
E5	4.7	8.7
E6	0.5	7.2
E7	0.1	3.7
E8	0.0	1.0
E9	0.0	0.4
Total	100.0	100.1
Occupation		
Seaman Recruit and Other Ship	58.2%	57.2%
Aviation	21.4	16.6
Administrative/Clerical	5.8	8.8
Other	14.6	17.4
Total	100.0	100.0

Hospitalization, Medical Board, and Physical Evaluation Board Rates

The number and rate of hospitalizations, medical boards, and physical evaluation boards occurring in the post-disaster period are shown in Table 2. During the study period subsequent to the disaster hospitalization, cases had a total of 353 hospitalizations, compared to 373 for controls. For cases, the mean number of hospitalizations was .44; for controls the mean was .45. The difference was not found to be statistically significant. Adjusting for follow-up time the hospitalization rate was .014 for cases and .013 for controls. The total number of medical boards for cases was 125, compared to 132 for controls. The mean number of medical boards was not found to be significantly different between cases and controls. Cases and controls differed significantly ($p=.02$) in their mean number of physical evaluation boards, with a total of 52 for cases, compared to 79 for controls.

TABLE 2

SUMMARY OF HOSPITALIZATION, MEDICAL BOARD, AND PHYSICAL EVALUATION BOARD OUTCOMES FOR CASES AND CONTROLS

	Cases			Controls		
	N	Mean	Rate	N	Mean	Rate
Hospitalizations	353	0.44	.014	373	0.45	.013
Medical Boards	125	0.16	.005	132	0.16	.004
Physical Evaluation	52	0.06	.002	79	0.10	.003

A life table analysis examining the time from disaster to the first subsequent hospitalization indicated that among cases there were 238 first hospitalizations compared to 235 among controls. The median time to the first hospitalization was 8 years for cases and 8.5 years for controls (see Table 3). The 1-year hospitalization rate for cases was 24%, and the 5-year rate was 44%, compared to 21% and 40% for the controls, respectively. The overall survival distributions (time to first hospitalization) were not found to be significantly different between cases and controls.

TABLE 3

SUMMARY OF LIFE TABLE ANALYSES

	Cases	Controls	Log Rank	P
First Hospitalization	N=238	N=235	0.91	.34
1-year rate	24%	21%		
5-year rate	44%	40%		
Median time (years)	8	8.5		
Second Hospitalization*	N=65	N=86	1.04	.31
1-year rate	5%	4%		
5-year rate	14%	17%		
First Psychiatric Hospitalization*	N=39	N=41	0.06	.81
1-year rate	3%	3%		
5-year rate	10%	7%		
First Medical Board*	N=88	N=132	7.67	.006
1-year rate	10%	14%		
5-year rate	14%	20%		
First Physical Evaluation Board*	N=52	N=79	3.12	.08
1-year rate	4%	11%		
5-year rate	5%	16%		

* Median time not reported because event occurred in less than 50% of subjects

The time from disaster to a second hospitalization was also examined in a life table analysis. There were 65 second hospitalizations among cases and 86 among controls. The 1-year second hospitalization rate was 5% for cases and the 5-year rate was 14% compared to 4% and 17% for controls, respectively. No significant difference was found in the overall distribution of second hospitalization times between cases and controls. An additional life table analysis was conducted to examine the time from disaster to the first subsequent hospitalization in which the primary or secondary diagnosis was psychiatric. This analysis showed 39 hospitalizations for cases and 41 for controls. The 1- and 5-year psychiatric hospitalization rates were 3% and 10% for the cases, compared to 3% and 7% for controls, respectively: however, the 10-year hospitalization rates were similar in both groups (cases=10%, controls=11%). The

survival distributions of time from disaster to the first psychiatric hospitalization were significantly different between cases and controls ($p<.01$). Cases were significantly more likely to be hospitalized with psychiatric diagnoses at an earlier time interval from disaster than controls.

First medical board and physical evaluation board events after disaster were also examined using a life table analysis. The analysis of time from disaster to the first medical board showed 88 first medical boards for cases and 132 for controls. The 1- and 5-year rates were 10% and 14% for cases, and 14% and 20% for the controls, respectively. The survival distributions of time from disaster to the first medical board and first physical evaluation board were not significantly different between cases and controls.

Post-Disaster Hospitalization Rates for Major Diagnostic Categories

Since the number of incident diagnoses within each major diagnostic category was small and incidence rates were not homogenous across age groups, age-specific incidence rates are presented. These rates per 1,000 strength based on person-years of follow-up, relative risk estimates, and approximate 95% confidence intervals for each diagnostic group are shown in Table 4. In general incidence rates for post-disaster hospitalizations by major diagnostic groups did not differ between cases and controls across the three age groups examined. Accident-related diagnosis had the highest incidence rates for both cases and controls in the 17-19 and 20-24 age groups. The risk of post-disaster accident-related diagnoses was significantly elevated in 17-19 year old cases (RR=1.67). In the 25+ age group, cases were at an increased risk of musculoskeletal disorders (RR=4.51) and neoplasms (RR=11.8), although the estimate for neoplasms was based on only one incident diagnosis for both cases and controls. In contrast, cases in the 20-24 year age group were at a significantly decreased risk of skin disorders (RR=.43). For all conditions combined, cases in the 17-19 age group were at a significantly increased risk of an incident hospitalization, whereas cases in the 25+ age group were at a significantly decreased risk. For the 20-24 year age group, there was no difference in risk between cases and controls.

TABLE 4

POST-DISASTER INCIDENT HOSPITALIZATION RATES (PER 1,000 STRENGTH), RELATIVE RISK ESTIMATES, AND 95% CONFIDENCE INTERVALS BY AGE GROUP AND DIAGNOSTIC CATEGORY

	Age Group					
	17-19		20-24		25+	
	N	Rate	N	Rate	N	Rate
Infectious diseases						
Cases	6	6.7	9	8.2	0	
Controls	9	12.7	14	14.7	1	1.2
RR (CI)	.53	(.17-1.67)	.56	(.26-1.14)		
Neoplasms						
Cases	2	2.2	3	2.7	1	14.2
Controls	2	2.8	2	2.1	1	1.2
RR (CI)	.79	(.03-22.65)	1.29	(.11-14.88)	11.80	(1.70-81.98)**
Diseases of the endocrine system						
Cases	0		1	1.1	0	
Controls	1	1.4	1	1.0	1	1.2
RR (CI)			1.10	(.31-3.86)		
Mental Disorders						
Cases	16	18.0	19	17.3	1	14.2
Controls	12	16.9	16	16.8	8	10.0
RR (CI)	1.06	(.77-1.40)	1.03	(.68-1.57)	1.42	(.43-4.73)
Diseases of the nervous system						
Cases	4	4.5	4	3.6	0	
Controls	3	4.2	6	6.3	4	5.0
RR (CI)	1.07	(.54-2.13)	.57	(.19-1.73)		
Diseases of the circulatory system						
Cases	3	3.4	7	6.4	0	
Controls	0		2	2.1	15	18.8
RR (CI)			3.05	(.76-4.54)		
Diseases of the respiratory system						
Cases	15	16.9	15	13.6	1	14.2
Controls	10	14.1	7	7.3	9	11.3
RR (CI)	1.20	(.70-2.06)	1.86	(.69-5.03)	1.26	(.48-3.28)
Diseases of the digestive system						
Cases	10	11.2	9	8.2	1	14.2
Controls	6	8.4	9	9.4	10	12.5
RR (CI)	1.33	(.62-2.84)	.87	(.48-1.56)	1.14	(.56-2.31)
Diseases of the genitourinary system						
Cases	7	7.9	6	5.4	0	
Controls	6	8.4	3	3.1	7	8.8
RR (CI)	.94	(.66-1.34)	1.74	(.36-8.46)		
Diseases of skin and subcutaneous tissue						
Cases	4	4.5	7	6.4	0	
Controls	4	5.6	14	14.7	6	7.5
RR (CI)	.80	(.09-6.93)	.43	(.19-.96)**		
Diseases of the musculoskeletal system						
Cases	8	9.0	16	14.5	2	28.4
Controls	9	12.7	16	16.8	5	6.3
RR (CI)	.71	(.22-2.34)	.86	(.54-1.37)	4.51	(1.32-15.50)**
Accidents, poisoning, and violence						
Cases	44	49.5	48	43.6	0	
Controls	21	29.6	29	30.4	12	15.0
RR (CI)	1.67	(1.10-2.52)**	1.43	(.83-2.49)		
Symptoms and ill-defined conditions						
Cases	7	7.9	9	8.2	1	14.2
Controls	4	5.6	8	8.4	3	3.8
RR (CI)	1.41	(.52-3.80)	.98	(.81-1.19)	3.74	(.68-20.5)
Total						
Cases	126	141.6	153	139.0	7	99.2
Controls	87	122.5	127	137.1	82	102.7
RR (CI)	1.16	(1.06-1.28)**	1.04	(1.00-1.08)	.97	(.96-.98)**
Person-years at risk						
Cases	889.58		1100.33		70.54	
Controls	710.31		954.44		798.44	

** p<.05

Discussion

Several previous studies of survivors of disasters have indicated these events are associated with adverse health sequelae in the post-disaster period. These studies have examined a variety of both man-made and natural disaster and report increased rates of morbidity[7,8,9,13,17,18] and increased rates of hospitalization and physician visits[9,11] in the post-disaster period. In contrast, the purpose of this study was to compare hospitalized disaster victims with non-disaster hospitalized patients to separate the effect of the hospitalization. In general, the results of the present study demonstrate that the health outcomes in the post-disaster period among U.S. Navy personnel who were survivors of disasters were similar to the health outcomes of controls.

The results were similar for the mean number of post-disaster hospitalizations, time from the disaster to the first and second hospitalizations, and the time for the first medical and physical evaluation boards. Thus, although the causes for the original hospitalization for the two groups were quite different, the follow-up care (number and timing of subsequent hospitalizations) and administrative management (medical boards) was similar. Differences between the two groups were found. For accidents, the relative risk in the 17-19 age group was significantly elevated. Disaster victims were younger and on active duty for a shorter period of time, possibly reflecting that younger men are more likely to be exposed to dangerous situations. Certainly the majority of a ship's crew, for example, are young sailors. Additionally, it was stated above that there were more chronic diseases in the control group, which is consistent with more of them having medical and physical evaluation boards. Secondary life table analysis of the time from disaster to major health outcome events including first and second hospitalizations and physical evaluation boards did not reveal significant differences in the time to response (survival) distributions between cases and controls. No previous studies of post-disaster health outcomes have used life table analysis to describe the experiences of disaster victims, so it is not possible at the present time to compare these results to other investigations.

For the majority of diagnostic categories examined, post-disaster incident hospitalization rates did not differ between cases and controls. Although rates for cases in the present study did differ significantly from controls over four diagnostic categories, these associations were not observed consistently across all age groups. There are several theories that could account for this finding. Some may have had a history of previous accidents (accident

proneness), and what followed the index event was a continuation of an established pattern. Others may have continued to be exposed to high-risk situations that eventually resulted in involvement in additional accidents. Still others may have reacted to the index event as a significant life stress that resulted in their being less able to cope and thus more vulnerable to another accident. For accidents, the relative risk in the 17-19 age group was significantly elevated (1.76), but this association was not observed in older age groups. For skin disorders, cases 20-24 years of age were at a significantly decreased risk (.43), but this association was also not observed in other age groups. This lack of consistent association across age groups was also observed for neoplasms, musculoskeletal disorders, and for all conditions combined. In addition, given the number of comparisons being made, it is possible these differences may have been observed by chance and, therefore, may not be meaningful. Thus, both because of the inconsistent associations observed across age groups and the number of comparisons, the present results should be interpreted with caution.

This study also examined psychological outcomes in disaster victims. Several previous investigations have reported associations between disasters and the development of psychological disorders[1,8,9,11,19,20,22,23] although some reports in the literature have not used control groups in the analysis.[19,21,22,23] This study did not find a significantly elevated incidence rate for psychiatric hospitalizations among disaster cases compared to the hospitalized control group, but the time interval from disaster to first psychiatric hospitalization was significantly shorter for cases than controls. It is theorized that cases were exposed to a traumatic event, reacted to it and were given psychiatric help, as opposed to the controls, who had an equal number of psychiatric diagnoses, but because there was no traumatic incident, had the occurrence of their psychiatric diagnoses more evenly distributed over time.

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(U) A POST-DISASTER FOLLOW-UP HEALTH-RELATED OUTCOMES IN U.S. NAVAL PERSONNEL

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Adverse physical and psychological health outcomes following disasters have been widely reported in epidemiologic literature. However, these studies have primarily examined disasters in the civilian population. Military personnel are at particular risk of involvement in disasters because of the hazardous nature of their duty. The objective of this study is to assess the impact of disasters on the health status of Navy personnel. Navy enlisted personnel who were hospitalized survivors of disasters occurring between 1966 and 1979 were compared with personnel hospitalized for problems not resulting from disasters. Hospitalization, medical board, and physical evaluation board rates for the post-disaster period were compared between the two groups. The results of life table analyses showed that cases and controls did not differ significantly in their post-disaster medical event rates and diagnoses. However, it was found that psychiatric diagnoses occurred earlier in the post-disaster period among cases than among controls. Although, military personnel involved in disasters were likely to have an administrative outcome and medical course that

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is similar to other hospitalized patients, disaster victims' mental health problems are likely to occur following involvement in a disaster. In addition, for the 17 to 19 year old group, there is an increased possibility of disaster victims being involved in accidents in the future.